HUC 10290107 – Pomme de Terre
Water body identification numbers: 3822 and 1444
Pollutant(s): Organic sediment and unknown

Total Maximum Daily Load
Implementation Strategies

for

Piper Creek
Polk County, MO

Impairments: Organic Sediment and Unknown

Completed: March 31, 2022

Prepared by: Water Protection Program, Watershed Protection Section

Water Body Summary

Pollutant: Organic Sediment and Unknown

Name: Piper Creek and Town Branch
Location: Polk County near Bolivar

8-digit Hydrologic Unit Code (HUC):[1]
HUC 10290107 – Pomme de Terre

12-digit HUC Subwatersheds:
HUC 102901070303 – Piper Creek

Water Body Identification Number (WBID) and Hydrologic Class:[2]
WBIDs 3822 and 1444 – Class P

Designated Uses:[3]
Irrigation
Livestock and wildlife protection
Human health protection
Warm water habitat (aquatic life)
Whole body contact recreation category B
Secondary contact recreation

Impaired Use:
Warm water habitat (aquatic life)

Pollutants and Sources Identified on the 2008 303(d) List:
Organic sediment – Bolivar Wastewater Treatment Facility
Unknown – Unknown

Length and Location of WBID 710:
11.9 miles from mouth to Section 16, Township 47N, Range 9W

Length and Location of Impairment within WBID 710:
7.8 miles from the confluence of Piper Creek with Pomme de Terre River to Highway 83/Springfield Avenue in Bolivar, Section 12, Township 33N, Range 23W

[1] Watersheds are delineated by the U.S. Geological Survey using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS 2019). A hydrologic unit is a drainage area delineated to nest in a multilevel, hierarchical drainage system. A hydrologic unit code is the numerical identifier of a specific hydrologic unit consisting of a 2-digit sequence for each specific level within the delineation hierarchy (FGDC 2003).

[2] For hydrologic classes see 10 CSR 20-7.031(1)(F). Class C streams may cease flow in dry periods, but maintain permanent pools that support aquatic life.

[3] For designated uses see 10 CSR 20-7.031(1)(C) and 10 CSR 20-7.031 Table H. Presumed uses are assigned per 10 CSR 20-7.031(2)(A) and (B) and are reflected in the Missouri Use Designation Dataset described at 10 CSR 20-7.031(2)(E).

TABLE OF CONTENTS

1. Introduction

A total maximum daily load (TMDL) identifies water quality problems, possible causes of those problems, and provides targets for restoration. However, actual water quality improvements are often dependent upon voluntary actions and support from local communities and landowners residing within the watershed. This implementation strategies document is a companion to the TMDL report and provides supplemental information about actions that will implement the goals established in the revised TMDL for Piper Creek and Town Branch. The strategies in this document are specifically focused on stream protection and agricultural best management practices (BMPs) to benefit water quality in Piper Creek. The Town Branch Watershed Management Plan, developed by the Bolivar Community Watershed Group in January 2012, is a separate document specifically focused on reducing nitrogen, phosphorus, and total suspended solids in riparian, urban, residential, and undeveloped areas in the Town Branch subwatershed. The location of Piper Creek and its watershed are presented on Figure 1.

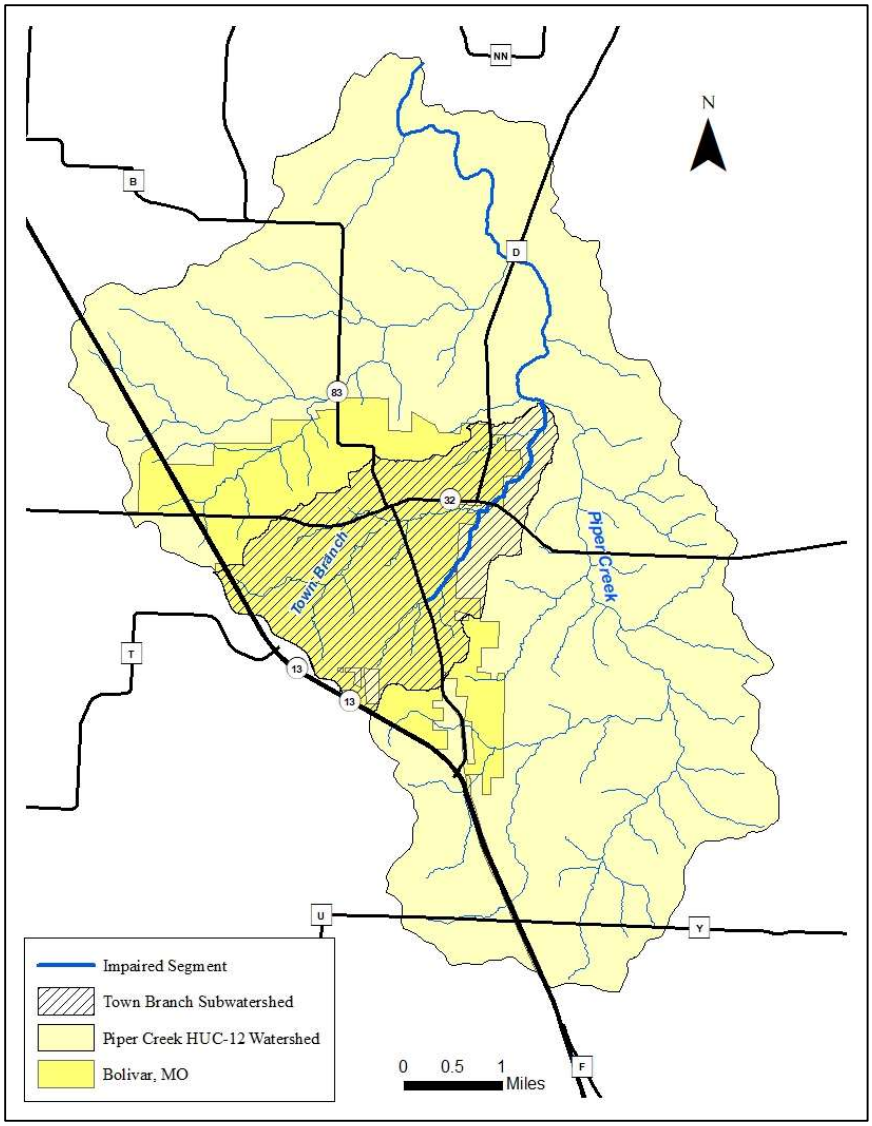

Figure 1. Piper Creek Watershed (HUC-12 102901070303)

The strategies in this document provide a guide for nonpoint source program coordinators, soil and water conservation districts, local governments, permitted entities, regional planning commissions, watershed managers, and citizen groups looking to implement nonpoint source loading reductions to achieve the load allocations established in the TMDL for Piper Creek. Reducing current pollutant loading to the allocations established in the TMDL will result in Piper Creek attaining its designated warm water habitat use for the protection of aquatic life. In this way, the TMDL serves as a "pollutant diet" for maintaining the environmental health of the stream. Background, watershed information, and specific pollutant loading targets and water quality objectives for Piper Creek can be found in the 2019 Revised TMDL for Piper Creek and Town Branch. The revised TMDL document is available on the Missouri Department of Natural Resources' website at https://dnr.mo.gov/document-search/piper-creek-town-branch-revised-total-maximum-daily-load. Questions regarding the TMDL may be sent via email to tmdl@dnr.mo.gov or by calling the Department's Watershed Protection Section at 573-751-5723.

This document is not intended to prescribe nor prohibit any specific practices or technologies for reducing pollutant loading in the impaired water body and is not intended to serve as the sole means of remediation and restoration. However, the Department recognizes that technical guidance and support are critical to achieving the goals of any TMDL. Therefore, while the TMDL calculates the maximum pollutant loading that the impaired stream can assimilate and still meet water quality standards, this strategies document provides additional information to assist in watershed management planning to meet TMDL loading goals.

In order to be eligible for Section 319 subgrants, a complete watershed management plan, that includes the Nine Elements listed in Appendix A of this document, must be submitted to the Department's Section 319 program prior to deadlines established for annual or biannual requests for grant proposals. For more information on Section 319 program requirements, please contact Trish Rielly at 573-526-4662. Local communities and citizens looking to develop organized watershed groups to improve water quality are also encouraged to contact the University of Missouri Extension at 573-882-0085. Information regarding the University Extension's water quality program is available online at fsb.missouri.edu/extension/waterquality/.

This document is intended to provide a starting point from which watershed groups may begin planning and implementing watershed management practices, as well as applying for grant funding. This document includes some information and estimates related to the required elements of a watershed management plan. However, all information in this document should be independently verified prior to including the information in any official grant application. In general this document touches on the following elements:

- Identification of the causes and sources or groups of similar sources that need to be controlled to achieve load reductions;
- Estimates of expected load reductions;
- Descriptions of nonpoint source management measures;
- Preliminary estimate of the amounts of financial assistance needed;
- Measurable Milestones; and
- Public education component to encourage participation.

Because each watershed management plan is uniquely tailored to the capabilities of the watershed group and the feasibility of implementation in each watershed, this document does not include the following elements:

- Final estimate of the amounts of technical and financial assistance needed;
- Schedule of implementation;
- Progress and Success Criteria; and
- Monitoring Program.

Potential nonpoint source management measures and estimated loading reductions are evaluated in Section 6. It is estimated that nutrient management practices would result in the greatest reduction in nutrient loading (15.9 percent) from hay and pasture lands in the Piper Creek watershed. Streambank stabilization coupled with the establishment of riparian buffers could reduce sediment loading by 35.8 percent. Nutrient management projects will have the greatest benefit to water quality in the Piper Creek watershed. Streambank stabilization projects will have the greatest benefit to the natural biological communities in Piper Creek and its tributaries.

2. Targeted Participants and Potential Roles in Implementation

The Department implements TMDL targets for point sources through the Missouri State Operating Permit program. For nonpoint sources, private landowners and citizen groups voluntarily implement water quality improvement projects and cost-share practices, which may be funded in part by grants or subgrants from the Department's Section 319 Nonpoint Source Implementation Program and the Soil and Water Conservation Program. Local governments, citizen groups, and individuals who have an interest in improving water quality in their communities may implement additional water quality improvement actions. Successfully meeting the goals of a TMDL often requires participation and cooperation from various parties within a watershed. Participant roles range from technical support to actual on-the-ground implementation of BMPs. Groups and agencies that may potentially be involved in the TMDL implementation process are identified below along with descriptions of their possible roles. This list is not exhaustive and not intended to compel participation from any organizations; nor is it meant to exclude those who are not listed, but may be interested in participating.

- Department of Natural Resources
  - Administers statutory authorities granted by Missouri clean water law
  - Ensures permits issued in the watershed are consistent with the assumptions and requirements of TMDL wasteload allocations (the allowable point source load)
  - Provides compliance assistance to regulated entities
  - Provides technical support to locally-led watershed groups
  - Serves as a potential source of financial assistance for watershed plan development and BMP implementation through Sections 319(h) and 604(b) grants, or through Soil and Water Program cost-share practices
  - Serves as a potential source of financial assistance for infrastructure improvements through low-interest State Revolving Fund loans
  - Assesses attainment of water quality standards on a biennial basis for Clean Water Act Sections 303(d) and 305(b) reporting

  - Provides education and training to volunteers through the Missouri Stream Team Program[4]
  - Provides technical assistance for market-based approaches to compliance such as water quality trading
- County Soil and Water Conservation Districts
  - Provide financial incentives to agricultural producers to implement conservation practices that help prevent soil erosion and protect water quality
  - Provide technical assistance with design, implementation, and maintenance of conservation practices
- University of Missouri Extension
  - Provides technical assistance for addressing nonpoint source and watershed management issues
  - Assists with organizing locally led watershed groups
- Missouri Department of Conservation
  - Provides technical assistance with stream and watershed management issues
  - Promotes maintenance and reestablishment of stable streambanks and functional riparian corridors
- Missouri Department of Health and Senior Services
  - Provides technical assistance pertaining to onsite wastewater treatment systems (i.e., septic)
- County Health Departments
  - Provide technical assistance pertaining to onsite wastewater treatment systems
- Bolivar Wastewater Treatment Facility
  - Operate in accordance with stated permit limits, conditions and schedules
  - May participate in water quality trading implementation
- Bolivar Municipal Separate Storm Sewer System (MS4)
  - Operate in accordance with stated permit conditions and schedules
  - May participate in water quality trading implementation
- Locally led watershed groups
  - Develop and implement Section 319-funded nine key element watershed-based plans.[5] (See Appendix A)
  - Identify critical areas at a local level
  - Implement BMPs to reduce nonpoint source pollutant loading
  - Provide public education and outreach
- Stream Team volunteers
  - Collect screening level water quality data (i.e., dissolved oxygen and biological monitoring) through the Volunteer Water Quality Monitoring program
  - Provide stewardship, advocacy, and education

[4] The Missouri Stream Team Program is a partnership between the Department of Natural Resources, the Department of Conservation, the Conservation Federation of Missouri, and the citizens of Missouri. The Stream Team Program provides an opportunity for all citizens to get involved in river conservation. Additional information regarding the Stream Team program is available online at mostreamteam.org.

[5] Guidance for developing a successful watershed-based plan that incorporates the U.S. Environmental Protection Agency's nine minimum elements is available online at www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters. These nine elements are required for plans funded with incremental Clean Water Act section 319 funds and are recommended for inclusion in all other watershed plans.

- Citizens living and working within the watershed
  - Voluntarily implement structural and nonstructural BMPs on private lands, residences, and businesses, such as limiting fertilizer use, maintaining septic systems, conserving water, controlling erosion, limiting runoff, and managing manure

3. Why was a TMDL Developed for Piper Creek?

Section 303(d) of the federal Clean Water Act and Title 40 of the Code of Federal Regulations Part 130 require states to develop TMDLs for water bodies not meeting applicable water quality standards. Missouri's Water Quality Standards consist of three major components: designated uses, water quality criteria, and an antidegradation policy. Descriptions of each of these components can be found in the 2019 revised TMDL. Piper Creek is not attaining designated aquatic life protections for warm water habitat due to violations of Missouri's general criteria as evidenced by low quality benthic macroinvertebrate communities and excessive sediment deposition. The impairment was identified as "unknown" pollutants from "unknown" sources on the 2008 303(d) List of Impaired Waters. If Piper Creek were to be listed today, the unknown impairment would likely be identified as natural biological aquatic communities due to nonpoint source pollutants.

4. Impairments, Causes, and Sources

Biological Assessment studies were conducted on Piper Creek in 2003-2004, and again in 2015-2016 at the sample points presented on Figure 2. The 2003-2004 study found that the benthic macroinvertebrate communities in Piper Creek were impaired, and the 2015-2016 study found no improvement to the benthic macroinvertebrate communities in Piper Creek.

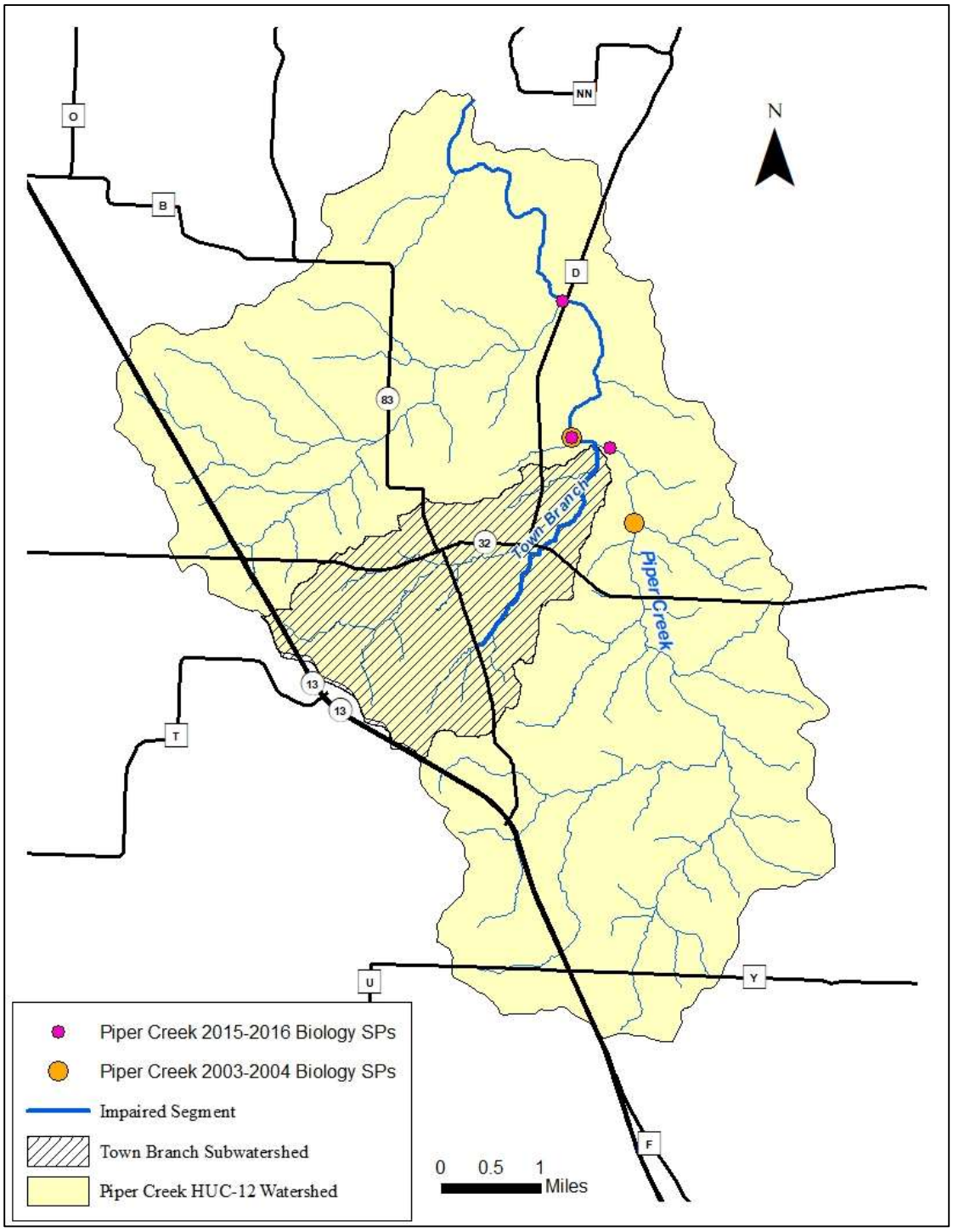

Figure 2. Locations of Biologic Assessment Sample Points

The Department collected sediment data on Piper Creek upstream and downstream of Town Branch in March 2004, May 2004, July 2005, and March 2006. As summarized in Table 1, the stream sediment data showed high average percentages of biochemical oxygen demand (BOD), total suspended solids (TSS), volatile suspended solids (VSS), and percent fine sediment (<2 mm) in Piper Creek both upstream and downstream of the Town Branch subwatershed.

Table 1. 2004-2006 Average Percent of Total Upstream and Downstream Sediment Characteristics and Percent Cover by Fine (<2 mm) Sediment 2004-2006

Sample Location	BOD %	TSS%	VSS%	Fine Sediment %
Piper Creek				
Upstream of Town Branch	50.4	70.5	67.0	72.8
Downstream of Town Branch	49.6	29.5	33.0	69.4

Sediment transported into streams contains nitrogen and phosphorus. Nitrogen requires oxygen for decomposition, and phosphorus promotes algae growth and impacts benthic macroinvertebrate communities. Although dissolved oxygen concentrations are not typically low in Piper Creek, morning to afternoon ranges fluctuate from around 6-7 mg/L to 11 mg/L. This indicates substantial coverage by benthic algae in the stream, which add oxygen during daytime photosynthesis and deplete oxygen overnight during respiration. Organic and fine eroded sediment deposition is detrimental to macroinvertebrate habitat because the spaces in coarse sediment where the larvae thrive become filled.

The primary cause of impairments to the biological communities in Piper Creek is nonpoint source loading in the watershed. Land cover in the Piper Creek watershed is presented on Figure 3.

As presented in Table 2 and Figure 4, hay and pasture lands are the dominant land cover type in the Piper Creek watershed. The percentages reflect areas outside of the Town Branch subwatershed. The Spreadsheet Tool for Estimating Pollutant Load (STEPL) (USEPA 2014) estimates that sediment loading from pastureland may be 8 times higher and phosphorus loading may be 3.5 times higher than from forest lands.

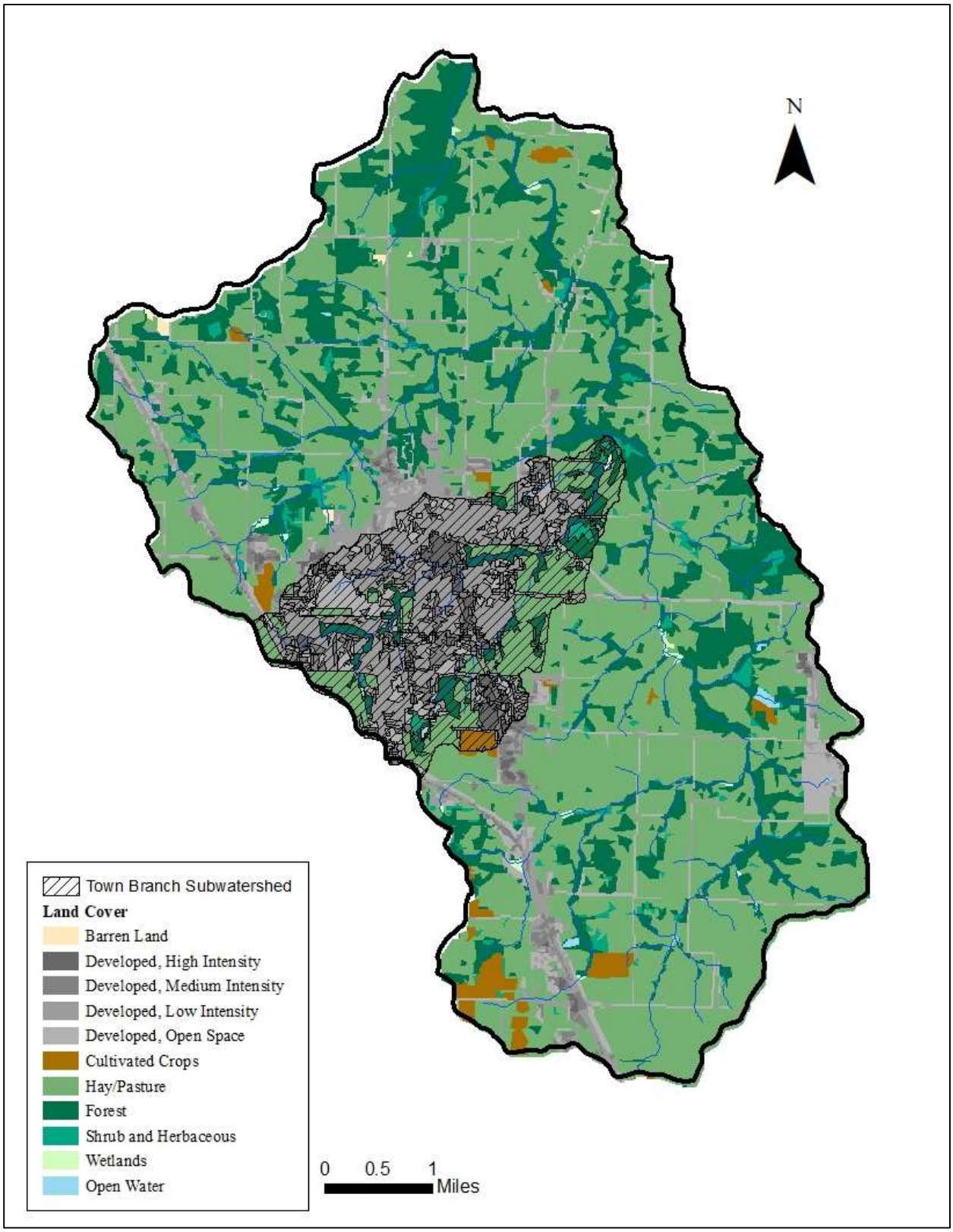

Figure 3. Land Cover in the Piper Creek Watershed

Table 2. Land Cover in the Piper Creek Watershed with the Town Branch Watershed Omitted

Land Cover Type	Area (acres)	Percent (%)
Hay and Pasture	12,532	62.0
Forest and Shrub and Herbaceous	4,870	24.1
Developed	2,352	11.6
Cultivated Crops	357	1.8
Wetlands	46	0.23
Open Water	27	0.13
Barren Land	24	0.12
	20,209	100

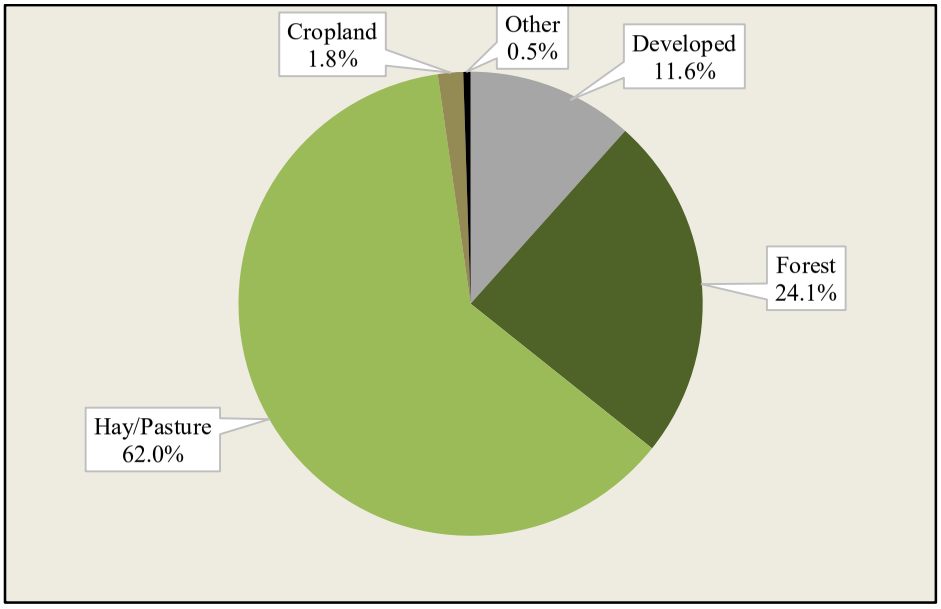

Figure 4. Proportion of Land Use Types in the Piper Creek Watershed

5. Existing Loads and Needed Reductions

Nitrogen and phosphorus are the two nutrients most often identified as impairing the quality of our ground and surface water. Nitrogen leaching out of the root zone can be transported to surface water or leach to groundwater. Nitrogen above 10 parts per million (ppm) in water is a health risk to both humans and animals. Phosphorus leachate or runoff attached to sediment particles entering the surface water contributes to excessive algae growth causing low oxygen levels in surface water that impairs aquatic life and contributes to bad tasting drinking water (NRCS 2003).

The STEPL calculations for the Piper Creek watershed estimated that 176,948 pounds of total nitrogen (TN) and 21,293 pounds of total phosphorus (TP) per year (485 lbs TN/day and 58 pounds TP/day) are transported via overland flow. Most of the nutrients originate from hay and pasture lands that drain to tributaries that enter Piper Creek. Total nonpoint source loading and loading by land cover type are presented in Figures 5 and 6.

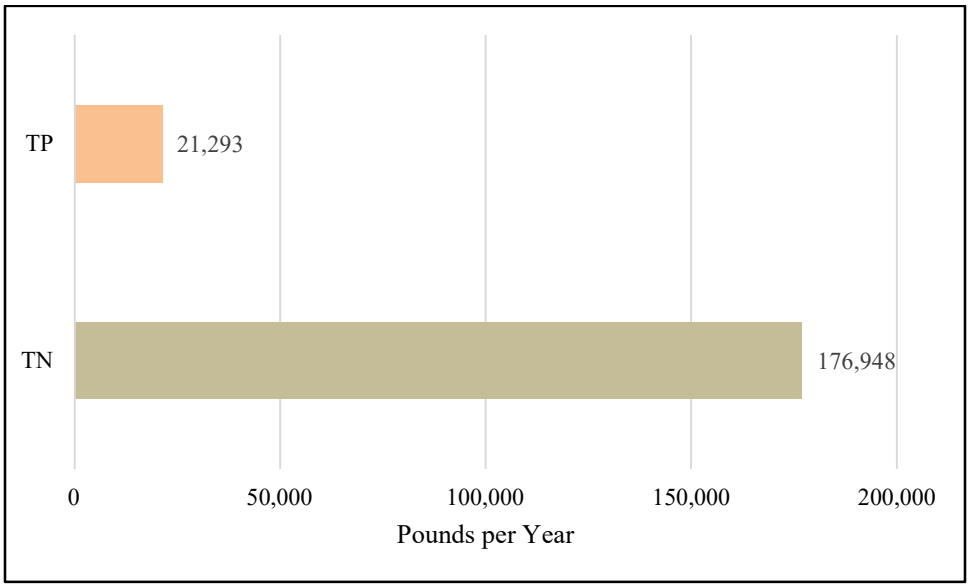

Figure 5. Annual Nitrogen and Phosphorus Loading in the Piper Creek Watershed

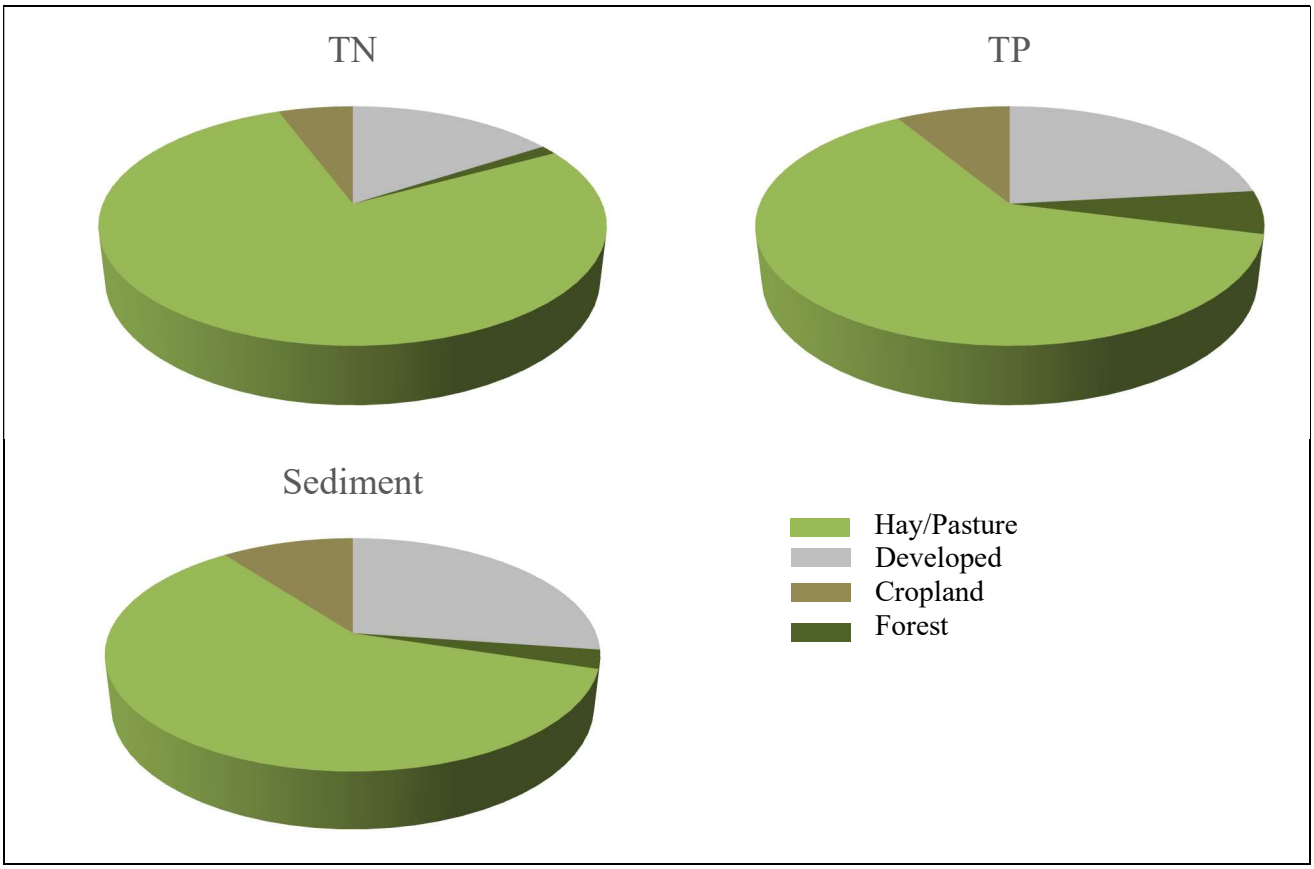

Figure 6. Loading by Land Cover Type

The revised TMDL for Town Branch and Piper Creek allocated nonpoint source loads of nitrogen and phosphorus based on 2016 USEPA benchmarks. Reductions in nutrient and sediment transport from nonpoint sources in the watershed are needed to restore the warm water habitat (aquatic life) designated use in Piper Creek.

A 47 percent reduction from the current nutrient and sediment loads estimated by STEPL was derived by calculating the average percent increase of fine sediment measured on Piper Creek downstream of Town Branch verses that measured on Town Branch upstream of the Bolivar Wastewater Treatment Facility in during the 2004-2006 sediment study (see Table 1). The resulting TN, TP, and sediment loading and the 47 percent reductions are presented in Figure 7.

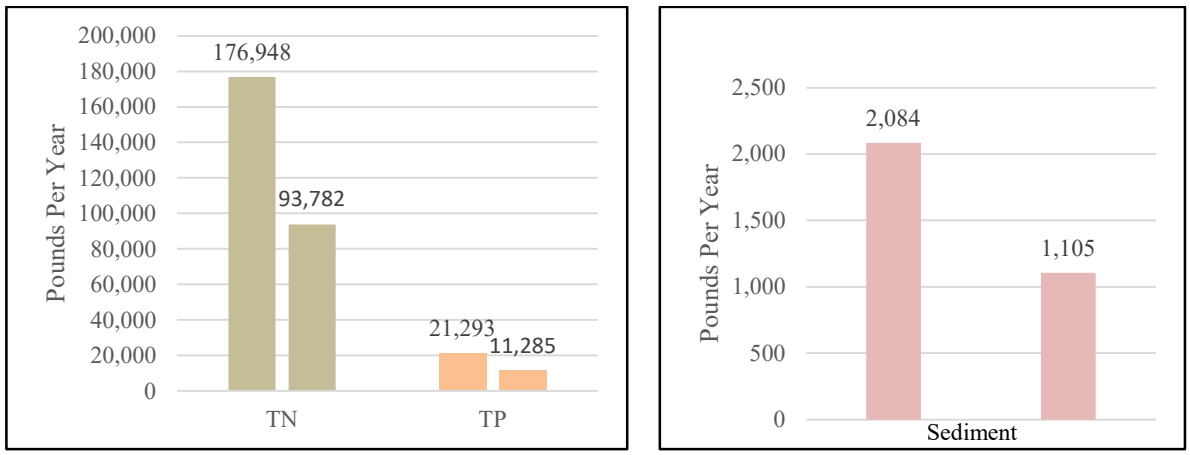

Figure 7. Annual Nitrogen, Phosphorus, and Sediment Loading in the Piper Creek Watershed with 47 Percent Reduction

6. Potential Nonpoint Source Management Measures and Expected Load Reductions

This implementation strategy focuses on reducing loading from hay and pasture lands because they are the largest contributor to loading in the Piper Creek watershed. Hay and pasture lands, especially those within the 100 foot buffer of Piper Creek and its tributaries are “critical areas” where nonpoint source management measures will be most effective. These areas are presented on Figure 8. Suggested nonpoint source management measured and the load reductions that may occur following implementation of the measures are summarized in the following sections.

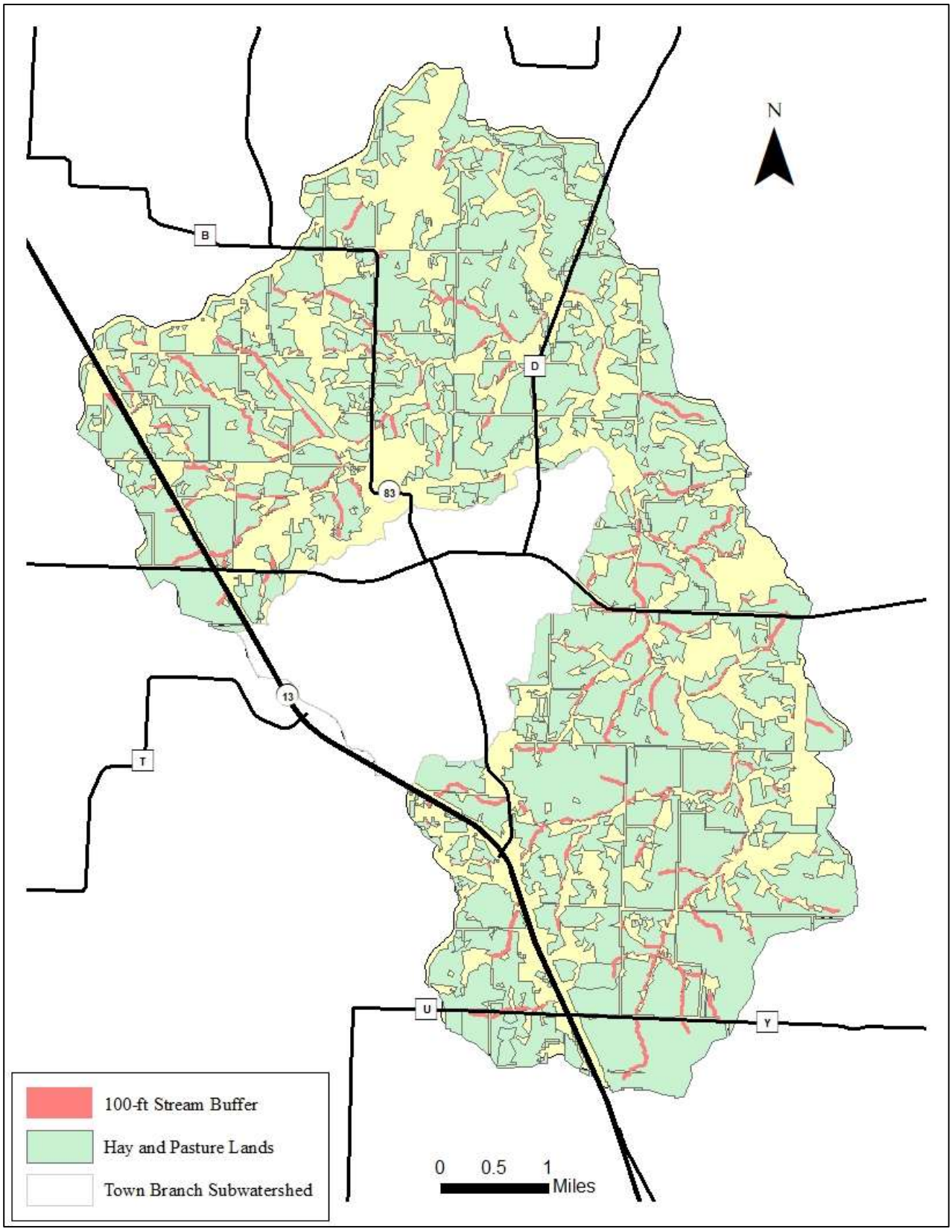

Figure 8. Critical Areas in the Piper Creek Watershed

6.1 Riparian Buffers

Riparian corridor conditions have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in erosion reduction, as well as the detention, removal, and assimilation of pollutants in runoff. Therefore, a stream with good riparian cover is often better able to mitigate the impacts of high pollutant loads than a stream with poor or no riparian cover. Shade provided by riparian corridors is also important because it helps to keep water cooler and reduce temperature variation especially during the critical low flows of July and August.

The extent of hay and pasture lands that are directly adjacent to Piper Creek and tributaries is shown in Figure 8. Creating riparian corridors within the 100-foot buffer of the streams will reduce erosion and nutrient transport from the adjacent lands. The total area of stream buffer and stream lengths that could benefit from the creation of riparian buffers are summarized in Table 3.

Table 3. Summary of Agricultural Lands within 100 foot Buffer of Piper Creek and Tributaries

Acres	Linear feet	Linear Miles
694	133,682	25.3

The STEPL model estimated that if 100-foot riparian buffers were created in all riparian areas currently covered by hay and pasture lands, this would result in the reductions presented in Table 4. The reductions do not include those that would result from concurrent streambank stabilization, which is discussed in the next section.

Table 4. Estimated Annual TN, TP, and Sediment Percent Reductions from Riparian Buffer Creation

TN	TP	Sediment
3.5%	1.9%	2.8%

6.2 Streambank Stabilization

In addition to the creation of riparian buffers, the majority of areas adjacent to Piper Creek and its tributaries that are within hay and pasture lands could likely benefit from streambank stabilization measures. Such measures may include the installation of live stakes, coconut fiber rolls and mesh, coir rolls, bank terracing, large woody debris, and large boulders to support streambanks and reduce erosion. Integrating shrub and tree planting with other bank stabilization measures results in long-term stabilization as the vegetative roots expand and provide further soil stability. Many resources are available to guide streambank stabilization design for specific conditions. A good initial reference is the *Army Corps of Engineers Streambank and Shoreline Protection Manual* (https://www.lrc.usace.army.mil/Portals/36/docs/regulatory/pdf/StrmManual.pdf).

A study of bank stabilization on the Cedar River in Nebraska[6] (Naisargi and Mittelstet 2017) found the average streambank erosion rate before stabilization was approximately 1.5 ft^2/ft and was reduced to 0.5 ft^2/ft after stabilization measures were implemented. As presented in Table 4, there are 133,682 linear feet of stream adjacent to hay and pasture lands in the Piper Creek watershed. This means there is twice as much (267,364) linear feet of streambank subject to erosion. Using the estimates developed for the Cedar River, average streambank erosion and the resulting reduction from bank stabilization would be as follows in Table 5.

[6] The Cedar River watershed is located in North Central Nebraska. The western half of the watershed is mainly grassland and sand dunes in the Sand Hills, whereas the eastern half is predominantly cropland.

Table 5. Estimated Streambank Erosion and Estimates of Annual Reductions from Bank Stabilization in the Piper Creek Watershed

Current Erosion	Erosion with Bank Stabilization	Erosion Reduction	Sediment Reduction	Phosphorus Reduction
401,046 cubic feet	133,382 cubic feet	67%	688 lbs	208 lbs

6.3 Livestock Exclusion

Livestock that have access to streams reduce streamside vegetation, increase barren areas, and contribute nutrients directly to streams. In addition, compaction from animals contributes to poor quality aquatic habitat because the interstitial spaces in stream substrate are eliminated. Excluding lifestock from streams is another way to improve water quality and aquatic habitat in the Piper Creek watershed.

6.4 Nutrient Management

The primary goal of nutrient management is to promote biomass productivity that provides profit for producers while minimizing negative environmental impacts. Over-application of nitrogen and phosphorus above the crop needs will cause these nutrients to accumulate in the soil and increase the potential for losses to the environment. Nutrient management planning minimizes the transport of nitrogen and phosphorus to surface and ground water by optimizing fertilizer application rates, timing, placements and accounting for all sources of nutrients.

Nutrient Management Plans may be eligible for cost-share programs through the Soil and Water Conservation Program. Nutrient Management Plans should be

developed in accordance with the NRCS Standards and Specifications for Nutrient Management (590) contained in the Polk County Soil and Water Conservation District Technical Guide.

In general, the following are required to begin nutrient management planning:

- Soil samples, based on a 7-inch depth, shall be taken once every 4 years, as a minimum, to monitor the phosphorus, potassium, pH and organic matter levels and adjust nutrient application rates as needed. The pH of the soil is important because it has a direct effect on nutrient availability. Follow Iowa State University recommendations and soil testing procedures to develop a crop budget for determining crop nutrient needs. Nitrate testing using the late spring nitrate test and fall corn stalk test can be used to monitor the nitrogen management program. Soil pH levels shall be maintained near 6.5 for corn and soybeans and 6.9 for alfalfa.

- Manure analysis could be completed on an annual basis for percent of solids, total N, organic N, NH_4, P_20_5, K_20 and pH. A more realistic nutrient content can be obtained by using the averages of three or more analysis.

- Soil tests and realistic yield potentials will be used to determine the application rate of manure so as to supply most of the crop nutrient needs through the manure and legume credits. No additional commercial phosphate or potash will be applied on soils testing high or very high in phosphorus and potassium (K). On these fields additional commercial nitrogen will be applied as needed. This will optimize crop yield potential while minimizing nutrient runoff and nitrogen leaching.

- Sensitive areas: Commercial nutrients, manure and organic by-products shall not be applied to frozen, snow covered ground or saturated soil on slopes greater than five percent unless erosion is controlled. Manure and organic by-products shall not be applied within 200 ft. of a stream, lake, agricultural drainage well, or sinkhole unless injected or incorporated within 24 hours.

- Risk Analysis: The phosphorus index will be used to determine fields that are a high risk for phosphorus losses. Conservation and/or management practices will be used to reduce the potential for phosphorus movement off site. Soil tests will be taken every four years to determine changes in phosphorus levels.

The plan should receive periodic review to determine if adjustments or modifications are needed. At a minimum the plan will be reviewed and revised with each soil test cycle.

Potential reductions in nutrient loading from nutrient management were estimated by reducing the TN and TP concentrations in milligrams per liter by 25 percent in the STEPL model. The resulting load reductions are listed in Table 7.

6.5 Field Borders

Field borders can provide a number of conservation benefits, such as reducing soil erosion from wind and water, protecting soil and water quality and providing habitat for wildlife. These habitats, located at the edges of crop fields, can also serve to connect other buffer practices and habitats within the agricultural landscape. The U.S. Department of Agriculture's Farm Service Agency (FSA) runs a program called the Continuous Sign-up Conservation Reserve Program (CCRP) that provides farmers with rental payments on land set-aside for conservation buffers for a period of 10-15 years. Cost-share payments are also made available to help farmers with the financial burden of establishing the buffers.

Potential reductions of TN, TP, and sediment loading were estimated based on establishing 25-foot field buffers around all hay and pasture lands in the Piper Creek watershed, which equates to 1,135 acres of additional forest land in the watershed. The potential loading reductions are presented in Table 6.

Table 6. Estimated Annual TN, TP, and Sediment Percent Reductions from Field Border Creation

TN	TP	Sediment
5.7%	3.1%	4.6%

6.6 Summary of Practices and Reductions

As presented in Table 7, nutrient management practices would result in the greatest reduction in nutrient loading (15.9 percent) from hay and pasture lands in the Piper Creek watershed. Streambank stabilization coupled with the establishment of riparian buffers could reduce sediment loading by 35.8 percent. Nutrient management projects will have the greatest benefit to water quality in the Piper Creek watershed. Streambank stabilization projects will have the greatest benefit to the natural biological communities in Piper Creek and its tributaries.

Table 7. Nutrient and Sediment Management Measures and Estimated Reduction

Practice	TN Load (Lbs/year)	TN Reduction	TP Load (Lbs/year)	TP Reduction	Sediment Load (Lbs/year)	Sediment Reduction
Existing Baseline	176,948	NA	21,293	NA	2,084	NA
Riparian Buffer	170,814	3.5%	20,888	1.9%	2,025	2.8%
Streambank Stabilization	NA	NA	21,085	1.0%	1,396	33.0%
Nutrient Management (25% reduction in runoff concentration)	148,900	15.9%	19,190	9.9%	NA	NA
Field Borders	166,917	5.7%	20,631	3.1%	1,988	4.6%
Total Reduction	**44,237**	**25%**	**3,386**	**15.9%**	**844**	**40.5%**

7. Preliminary Estimate of Financial Assistance Needed (20-Year Total)

The cost share estimates presented in Table 8 were derived from the Department's Soil and Water Conservation Program historic cost share tables and estimates from the Missouri Department of Conservation. They are general estimates, and should be independently verified prior to inclusion in grant proposals. Based on the percent load reduction per dollar, streambank stabilization projects will provide the most efficient load reductions.

Table 8. Estimated Cost Share by Practice

Practice	Estimated Cost Share per Acre	Acres	20-Year Total	TN Reduction	TP Reduction	Sediment Reduction	Cost/Benefit Efficiency Rank
Livestock Exclusion	$180	6	$1080	Qualitative Improvement			
Riparian Buffer	$130	694	$90,220	3.5%	1.9%	2.8%	Low
Streambank Stabilization	$1,200	18	$21,600	NA	1.0%	33.0%	High
Nutrient Management	$18	12,532	$225,576	15.9%	9.9%	NA	Medium
Field Borders	$40	1,135	$45,400	5.7%	3.1%	4.6%	Low
Cumulative 20-Year Total Cost Share			**$383,876**	**25%**	**15.9%**	**40.5%**	

It is recommended that streambank stabilization projects be prioritized because the cost/benefit efficiency is high, and also because Piper Creek is impaired due to excessive sedimentation that is harmful to aquatic benthic macroinvertebrate habitat. Any streambank sedimentation project should include installation of some riparian buffer, and this will provide further benefit through long-term soil stabilization, shade, and wildlife habitat.

8. Potential Funding Sources

TMDLs are written to meet applicable water quality standards per federal regulations at 40 CFR 130.7(c)(1). As a result, they are developed without considerations of cost or available treatment technologies. However, BMP installations result in real-world costs that need to be considered before determining what technologies or actions to employ in order to meet the calculated water quality targets. In many cases, TMDL implementation is partially a continuation of already permitted activities and costs are incurred as part of the normal operation and maintenance of those permitted systems. Other point source costs may arise as a result of needed facility upgrades in order to meet specified permit limits or conditions. For nonpoint sources, costs associated with installing and maintaining BMPs depend upon the type, number, and complexity of the practice. Fortunately, a single BMP may address several pollutants or degradation pathways, thereby compensating for the overall costs by providing additional water quality benefits. Estimates of BMP costs are available online from the International Stormwater BMP Database at bmpdatabase.org.

To offset costs associated with facility upgrades or BMP implementation, a variety of grants and loan programs are available to assist watershed stakeholders. The most commonly used sources of funding are low-interest loans through the State Revolving Fund, Section 319 subgrants, and cost-share practices through the state's Soil and Water Conservation Program.

Low-interest loans from the Clean Water State Revolving Fund are available through the Department's Water Protection Program Financial Assistance Center. The State Revolving Fund provides subsidized loans to municipalities, counties, public sewer districts, and political subdivisions for wastewater infrastructure projects. Loans may be paired with grant funds for qualifying communities. Information on the Department's grant policy is available online at dnr.mo.gov/env/wpp/srf/wastewater-assistance.htm. Eligible projects include new construction or improvement of existing facilities. More information regarding the State Revolving Fund Program is available online at dnr.mo.gov/env/wpp/srf/index.html.

The Missouri Agricultural and Small Business Development Authority offers an Animal Waste Treatment System Loan Program in cooperation with the Clean Water State Revolving Fund. Animal Waste Treatment Loans Program may finance eligible animal waste treatment systems for independent livestock and poultry producers with operations of less than 1,000 animals. Eligible costs include storage structures, land, dedicated equipment, flush systems, composters, and more. More information regarding the Animal Waste Treatment Loans Program is available online at agriculture.mo.gov/abd/financial/awloanprg.php.

By amendment to the federal Clean Water Act in 1987, the Section 319 grant program was established to provide funding for efforts to reduce nonpoint source pollution. The U.S. Environmental Protection Agency (EPA) provides 319 funding to the state, which in turn allocates a portion of the funding as subgrants to public and non-profit organizations to address nonpoint source concerns. Section 319-funded subgrants may be used to demonstrate innovative BMPs, support education and outreach programs, restore impaired waters, or protect waters from becoming impaired. More information regarding the Section 319 Nonpoint Source Implementation Program is available online at dnr.mo.gov/env/swcp/nps/index.html.

The Soil and Water Conservation Program provides financial incentives to landowners to implement practices that help prevent soil erosion and protect water quality. The program offers cost-share practices through its county conservation districts. Landowners may receive up to 75 percent reimbursement of the estimated cost of a practice through the program. The primary funding for cost-share practices from the Soil and Water Conservation Program comes from the one-tenth-of-one percent Parks, Soils, and Water Sales Tax. More information regarding the Soil and Water Conservation Program and cost-share practices is available online at dnr.mo.gov/env/swcp/service/swcp_cs.htm.

In addition to state sources of funding, federal assistance, public bonds, and private financing may also be available for TMDL implementation. For example, the U.S. Department of Agriculture through its Natural Resources Conservation Service provides various incentive and financial assistance programs for implementing BMPs that reduce pollutant loading from agricultural areas. Additionally, the EPA maintains the Catalog of Federal Funding, which is a searchable database for other financial assistance sources. Table 8 provides links to these as well as other federal funding sources.

Table 9. Online resources for potential funding sources

Name and URL	Description
U.S. Department of Agriculture Natural Resources Conservation Service https://www.nrcs.usda.gov/wps/portal/nrcs/site/mo/home/	Financial assistance and incentives to implement voluntary BMPs º Environmental Quality Incentives Program (EQIP) º Regional Conservation Partnership Program (RCPP) º Conservation Stewardship Program (CSP) º Agricultural Conservation Easement Program (ACEP)
Wichita State University, Environmental Finance Center (EFC) https://www.wichita.edu/academics/fairmount_college_of_liberal_arts_and_sciences/hugowall/efc/news/meramec-funding-sources-landing-page.php	Searchable database of funding opportunities
Catalog of Federal Funding https://www.epa.gov/waterdata/catalog-federal-funding	Searchable database for financial assistance sources
Nonpoint Source – Related Funding Opportunities http://water.epa.gov/polwaste/nps/funding.cfm	List of federal websites with information regarding funding opportunities
Environmental Education Grants http://www2.epa.gov/education/environmental-education-ee-grants	Financial support for environmental education projects
Environmental Justice Grants https://www.epa.gov/environmentaljustice/environmental-justice-grants-and-resources	Grant resources for Environmental Justice communities
Water Infrastructure and Resiliency Finance Center https://www.epa.gov/waterfinancecenter	Provides financing information for drinking water, wastewater and stormwater decisions
Grants.gov http://www.grants.gov	A common website for federal agencies to post funding opportunities

9. Measurable Milestones

Watershed management plans must be renewed every five years to stay eligible for Section 319 subgrants. Thus, specific goals and objectives should be developed on 5-year timeframes. The following milestones are intended to support maximum BMP implementation on a 20-year timeframe, with on-going funding dispersals based on the interim 5-year timeframes.

5-Year Milestones

- Conduct outreach and gain public participation for implementing BMPs and achieving nonpoint source load reductions in the long-term.
- Complete development, funding, and implementation of Nutrient Management Plans for 10 percent of hay and pasture lands in the Piper Creek watershed.
- Fund and construct bank stabilization and associated riparian buffer projects along 10 percent of stream linear feet adjacent to hay and pasture lands in the Piper Creek watershed.

- Increase livestock exclusion from streams in the Piper Creek watershed by 10 percent.

Estimated Total 5-year Cost: $36,362

10-Year Milestones

- Continued outreach and public participation for implementing BMPs and achieving nonpoint source load reductions in the long-term.
- Complete development, funding, and implementation of Nutrient Management Plans for 25 percent of hay and pasture lands in the Piper Creek watershed.
- Complete construction of bank stabilization and associated riparian buffer projects along 25 percent of stream linear feet adjacent to hay and pasture lands in the Piper Creek watershed.
- Increase livestock exclusion from streams in the Piper Creek watershed by 25 percent.

Estimated Total 5-year Cost: $54,543

15-Year Milestones

- Continued outreach and public participation for implementing BMPs and achieving nonpoint source load reductions in the long-term.
- Complete development, funding, and implementation of Nutrient Management Plans for 50 percent of hay and pasture lands in the Piper Creek watershed.
- Complete construction of bank stabilization and associated riparian buffer projects along 50 percent of stream linear feet adjacent to hay and pasture lands in the Piper Creek watershed.
- Increase livestock exclusion from streams in the Piper Creek watershed by 50 percent.

Estimated Total 5-year Cost: $90,905

20-Year Milestones

- Continued outreach and public participation for implementing BMPs and achieving nonpoint source load reductions in the long-term.
- Complete development, funding, and implementation of Nutrient Management Plans for 85 percent of hay and pasture lands in the Piper Creek watershed.
- Complete construction of bank stabilization and associated riparian buffer projects along 85 percent of stream linear feet adjacent to hay and pasture lands in the Piper Creek watershed.
- Increase livestock exclusion from streams in the Piper Creek watershed by 85 percent.

Estimated Total 5-year Cost: $127,267

10. Public Outreach Program and Strategy

Education and outreach activities are designed to inform the public on BMPs and conditions that relate directly to improvement of water quality within the watershed. Many avenues for outreach are available to residents of the watershed. Organizations such as the Environmental Protection Agency, Natural Resources Conservation Service, Soil and Water Districts, Missouri Department of Conservation, University of Missouri Extension, City of Bolivar and the Polk County Health Department provide much needed information to landowners regarding BMPs and give technical advice on practices or services that will benefit the land and water quality in the watershed.

The following activities are recommended for the development of support and participation to reduce nonpoint source loading to Piper Creek.

1. Hold meetings and other outreach events to inform private landowners of the available technical support and financial incentives for implementing BMPs.
2. Attend livestock auctions and demonstrations in the local community, and hand-out literature explaining the available technical support and financial incentives for implementing BMPs.
3. Develop small-scale demonstrations of BMPs.
4. Implement a public awareness campaign regarding water quality with public service announcements.
5. Host local watershed festivals.

11. Conclusion

The purpose of this TMDL implementation strategies document is to serve as a general guide to Department staff, soil and water conservation districts, local governments, permitted entities, watershed managers, and citizen groups for reducing existing pollutant loads to restore Piper Creek to conditions that attain water quality standards. The ultimate goal is to meet Missouri Water Quality Standards through the protection of aquatic life in warm water habitats. Implementation should follow an adaptive approach that makes progress toward achieving water quality goals while using new data and information to reduce uncertainty and adjust implementation activities. Implementation efforts are expected to occur over a number of years, but within the schedules established in state operating permits and Section 319 watershed-based plans. Success in achieving water quality standards will be determined by the Department through biennial assessments of water quality compliance as required by Sections 305(b) and 303(d) of the federal Clean Water Act.

The Department has an administrative record on file for the revised Piper Creek (Town Branch) TMDL. The record contains this implementation strategies document, the original 2010 TMDL report, the 2019 revision, and any studies, data or calculations on which loading targets are based. This information is available upon request to the Department at dnr.mo.gov/sunshine-form.htm. Any request for information about this TMDL will be processed in accordance with Missouri's Sunshine Law (Chapter 610, RSMo) and the Department's administrative policies and procedures governing Sunshine Law requests. For more information about open record/Sunshine requests, please consult the Department's website at dnr.mo.gov/sunshinerequests.htm.

This implementation strategies document is scheduled for a 45-day public notice and comment period in conjunction with the comment period for the 2019 Piper Creek (Town Branch) TMDL. Any comments received, as well as the Department's responses to those comments, will be maintained on file with the Department and posted online at dnr.mo.gov/env/wpp/tmdl/3822-town-br-1444-piper-ck-record.htm. The Department maintains an email distribution list for notifying subscribers of significant TMDL updates or activities. Those interested in subscribing to these TMDL updates can submit their email address using the online form at public.govdelivery.com/accounts/MODNR/subscriber/new?topic_id=MODNR_177.

12. References

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NRCS (Natural Resources Conservation Service). 2013. Nutrient Management Plan Narrative with Livestock. [Online WWW] Available URL: https://nerc.org › documents › comprehensive_nutrient_management [Accessed 2019].

USGS (U.S. Geological Survey). 2019. Hydrologic Unit Maps. [Online WWW] Available URL: https://water.usgs.gov/GIS/huc.html [Accessed 2019].

Appendix A
Nine Key Elements Critical to a Watershed Management Plan

a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan, as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded streambanks).

c. A description of the nonpoint source management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, U.S. Department of Agriculture's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

f. A schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

g. A description of interim, measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a nonpoint source TMDL has been established, whether the nonpoint source TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.